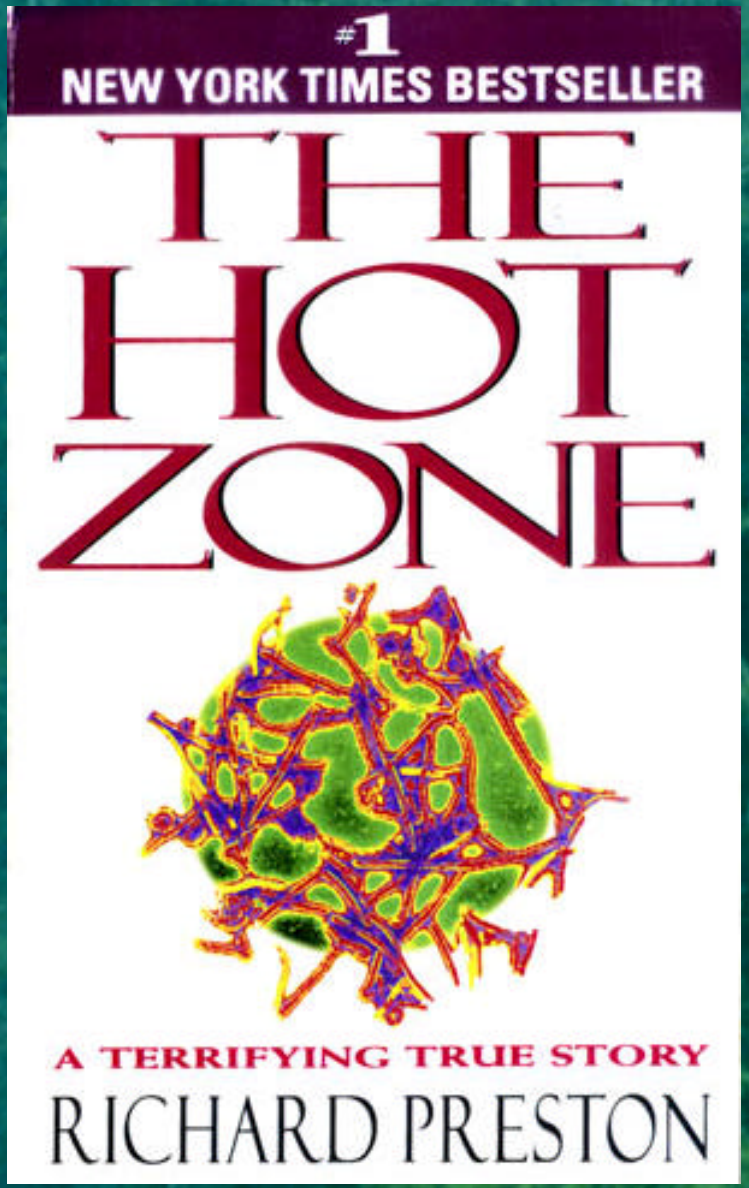
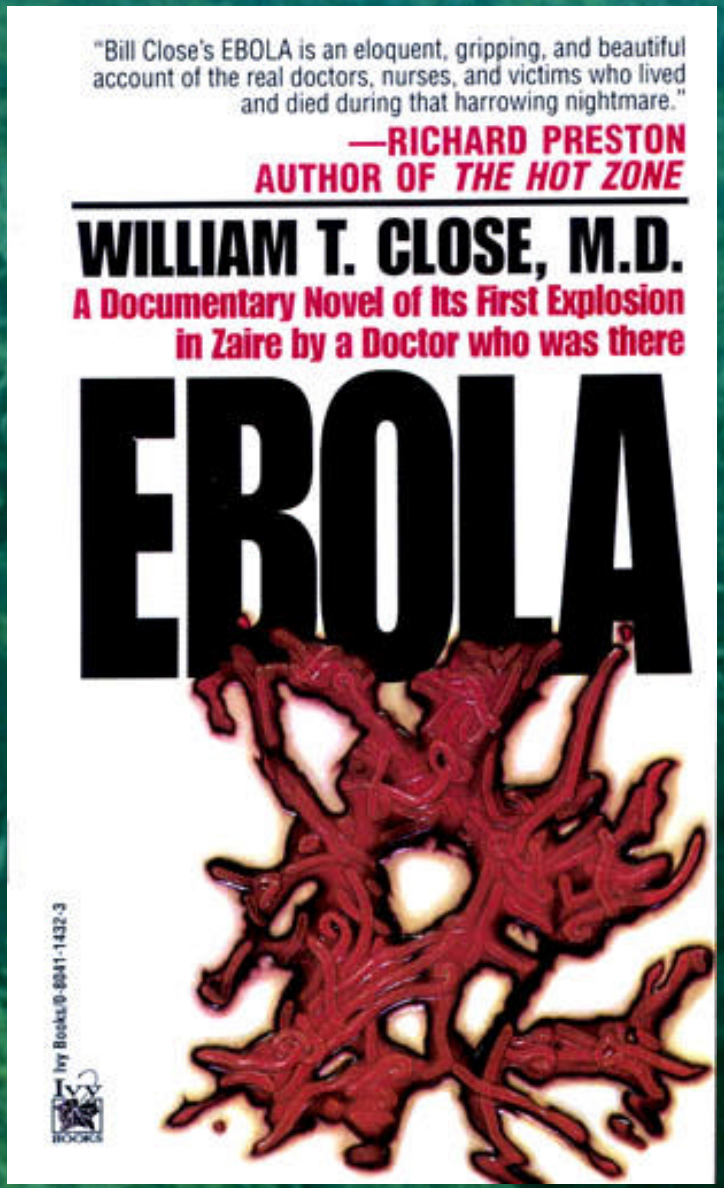
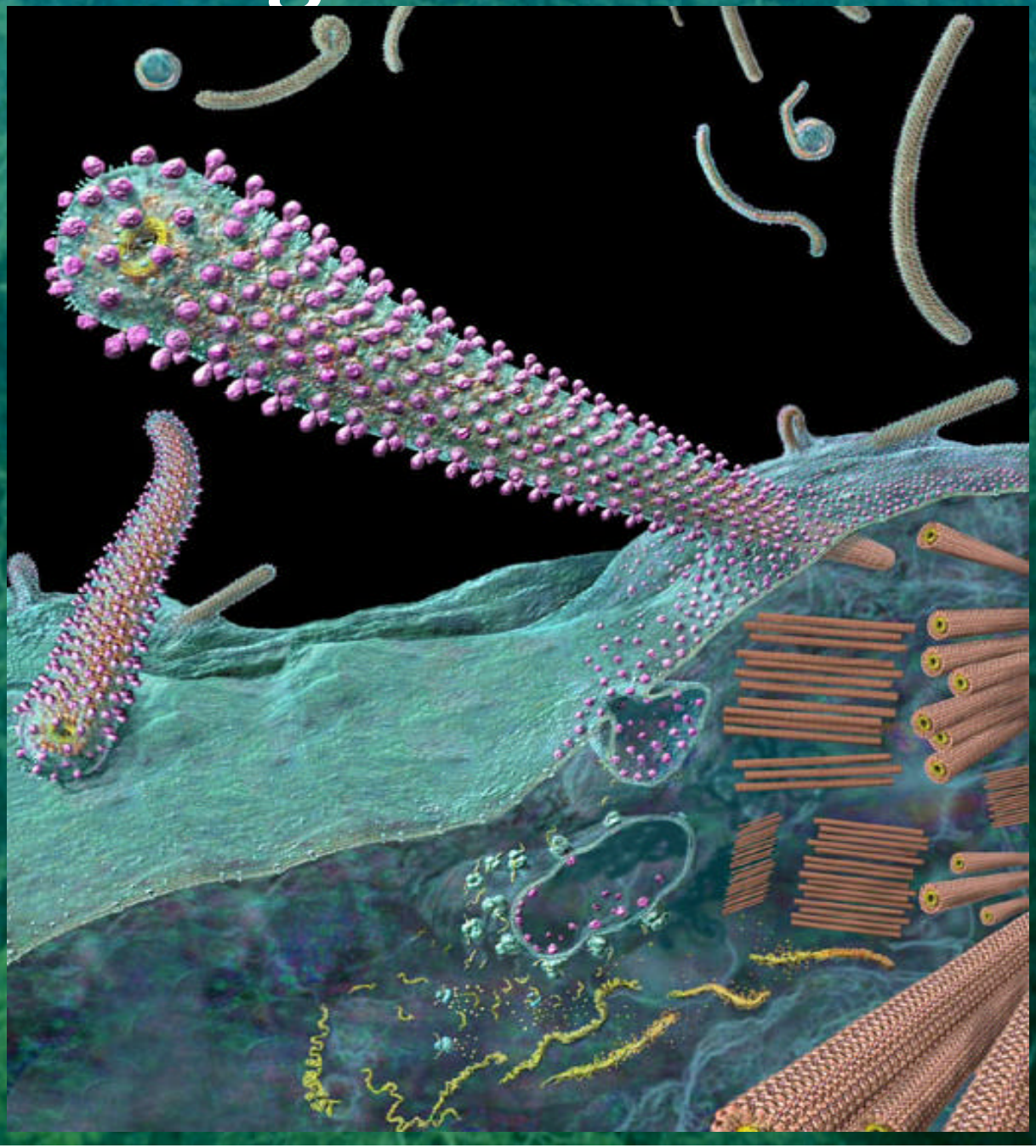
Ebola River Hemorrhagic Fever

Glamour disease of the era



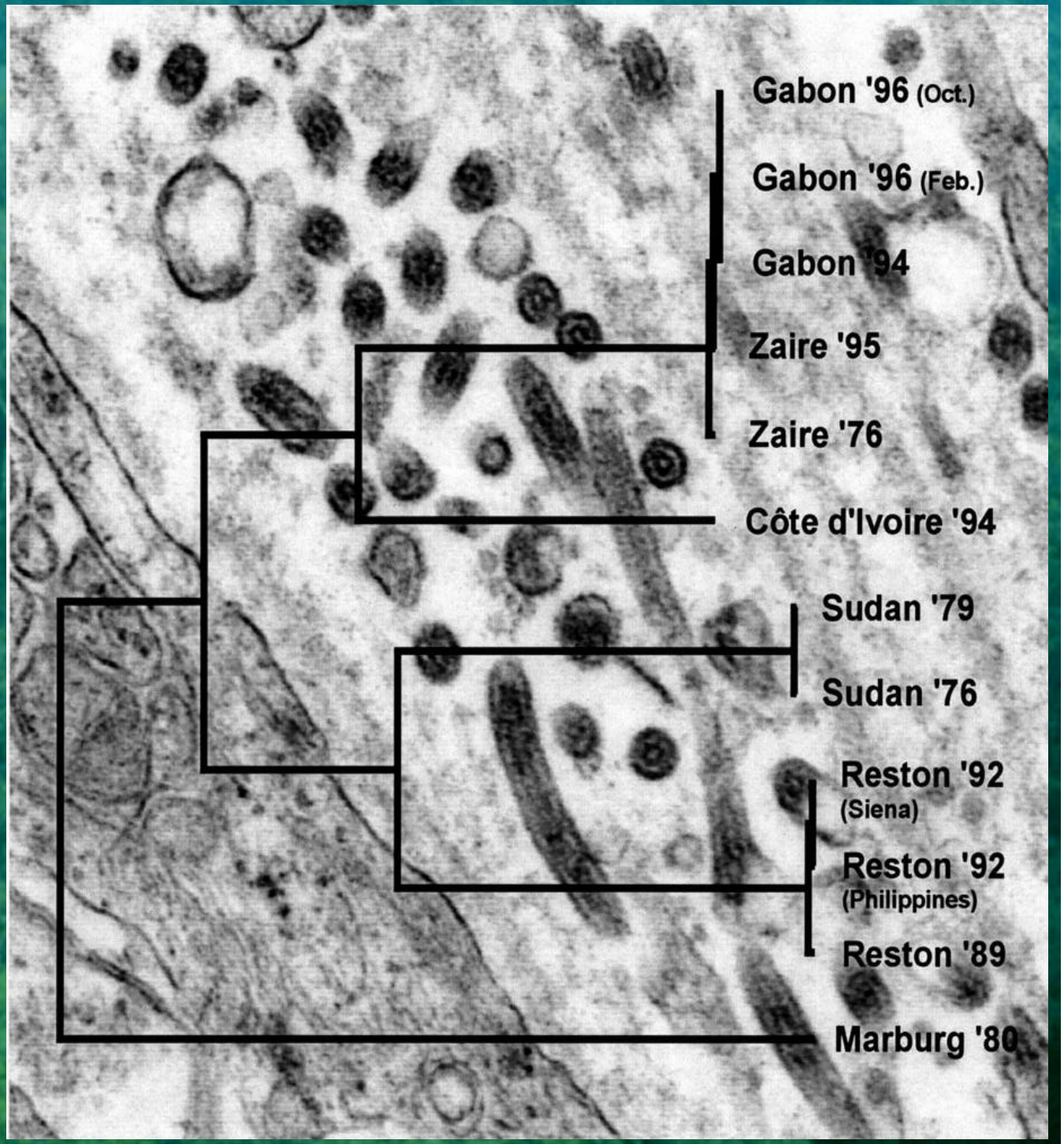


Ebola Hemorrhagic Fever Virus



Ebola Case Fatalities 60-80%

Ebola electron-micrograph in human skin tissue & evolutionary relationships of Ebola & Marburg viruses



Ebola outbreak locations

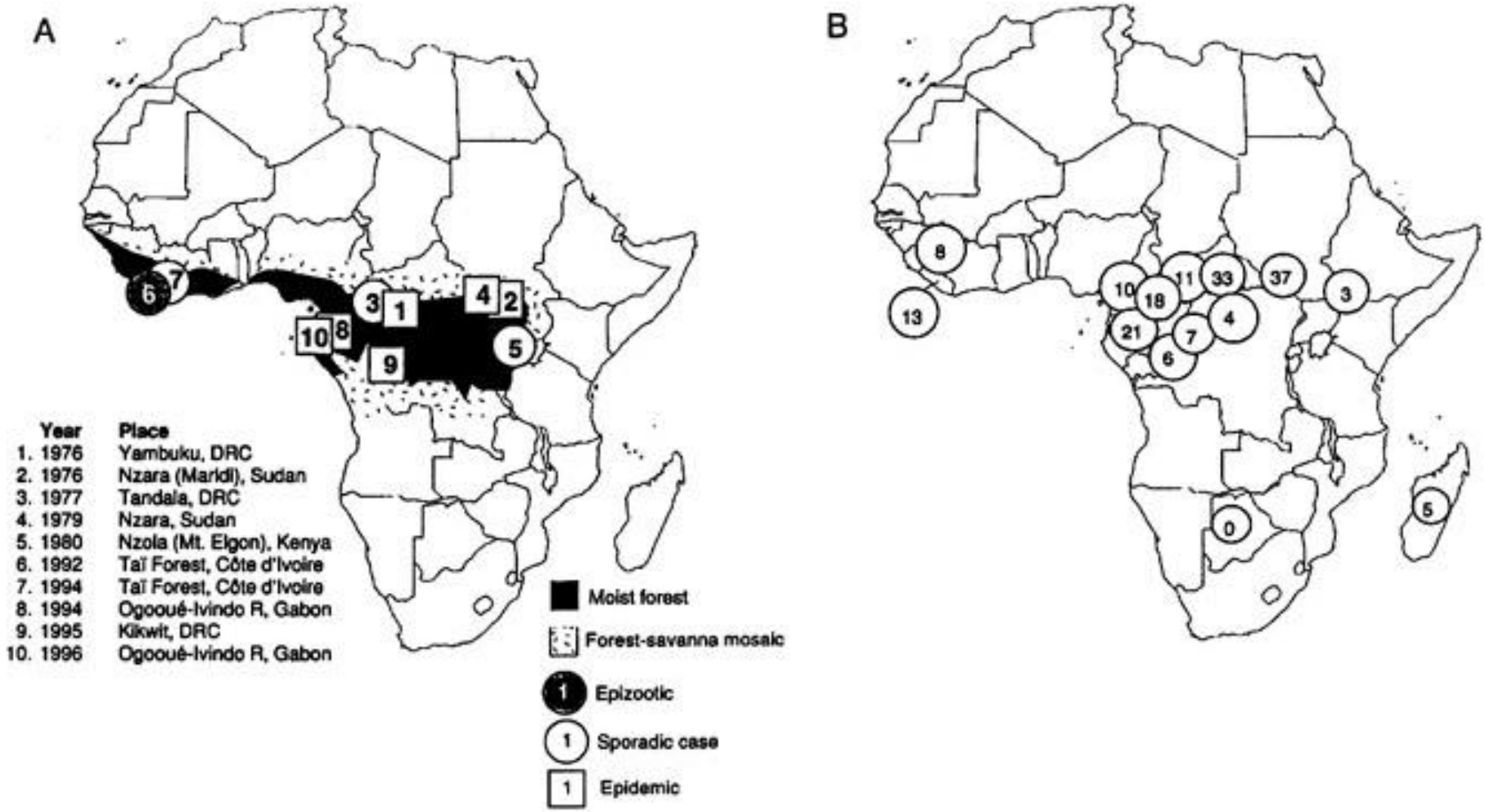
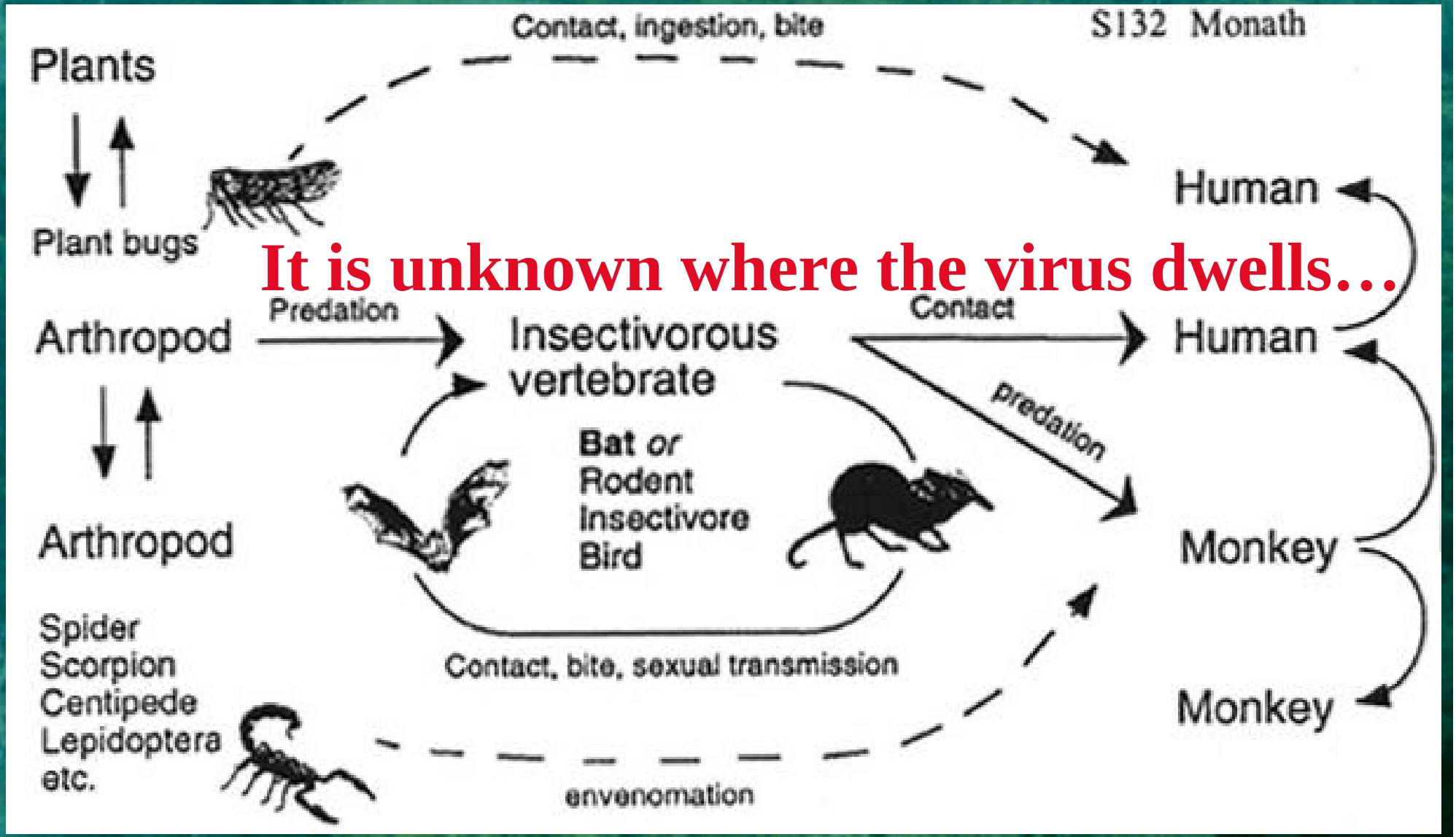


Figure 4. Distribution of Ebola virus disease incidents reported in Africa, 1976–1996 (**A**) and prevalence of IFA Ebola antibodies in various surveys [38, 42–45, 47, 58–62] (**B**). DRC = Democratic Republic of Congo.

Possible Ebola Transmission(s) no usual suspects!

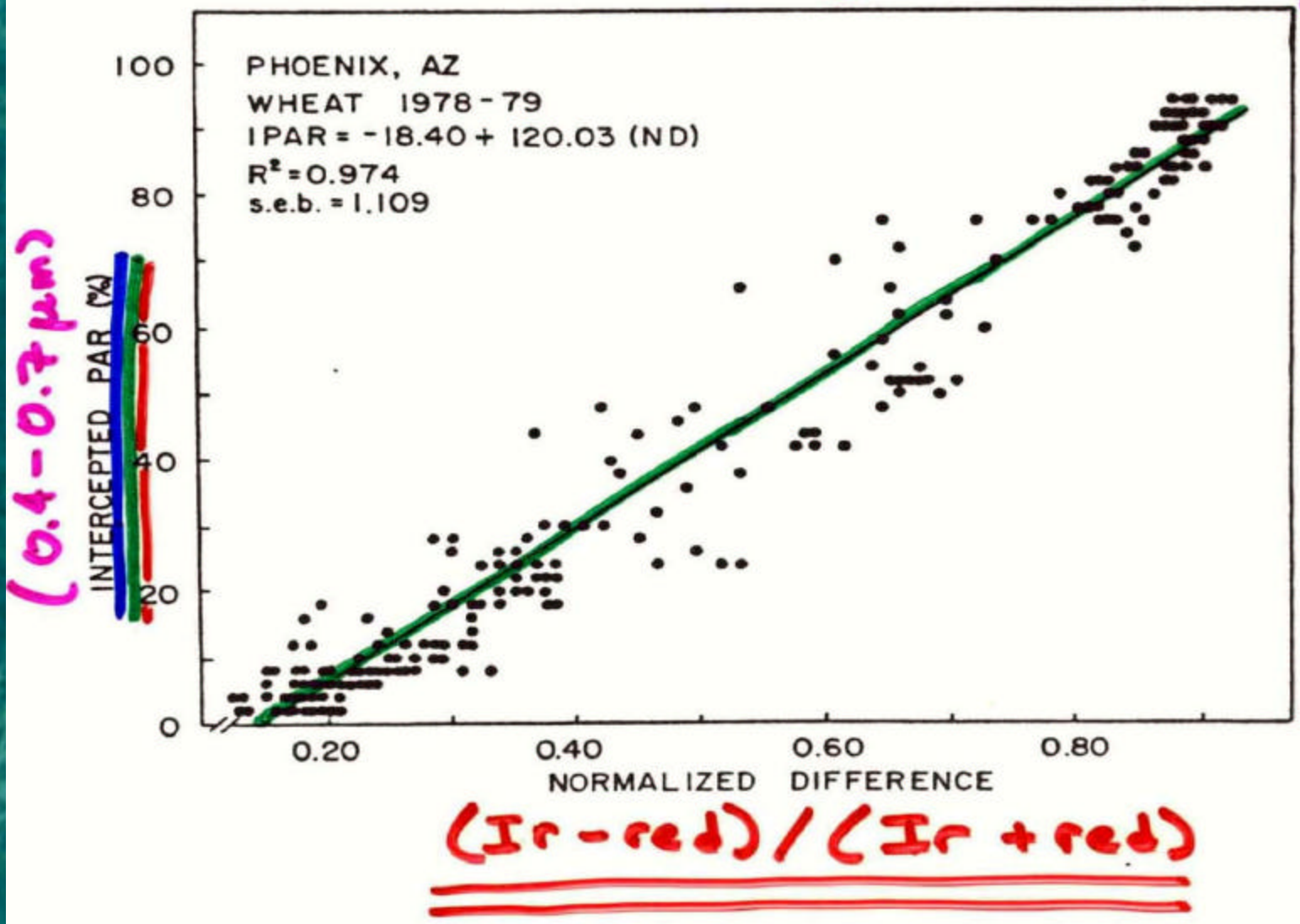


Ebola Outbreaks

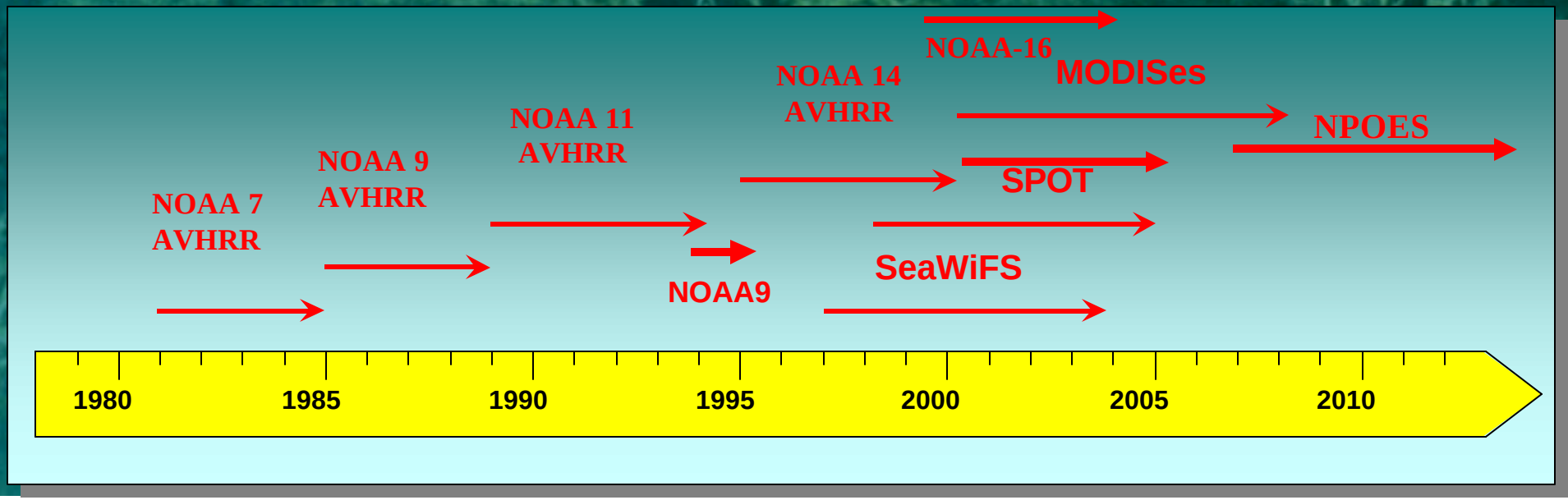
Epidemic Site	Date of Index Case Clinical Presentation	cases	fatalities
Narza and Maridi, Sudan	June 1974	284	151
Yambuku, Congo	September 1976	318	280
Tandala, Congo	June 1977	1	1
Narza, Sudan	July 1979	34	22
Tai, Cote d'Ivoire	October 1994	12/1	12/0
Mekouka, Andock, Minkebe, Gabon	November 1994	49	29
Kikwit, DRC	November 1994	315	242
Mayibout II, Gabon	January 1996	31	21
Booue, Gabon	July 1996	60	40
Gulu, Uganda	August 2000	385	210
Ogooue-Ivindo, Gabon	December 2001	79	47

NOAA AVHRR 8-km NDVI Data Set

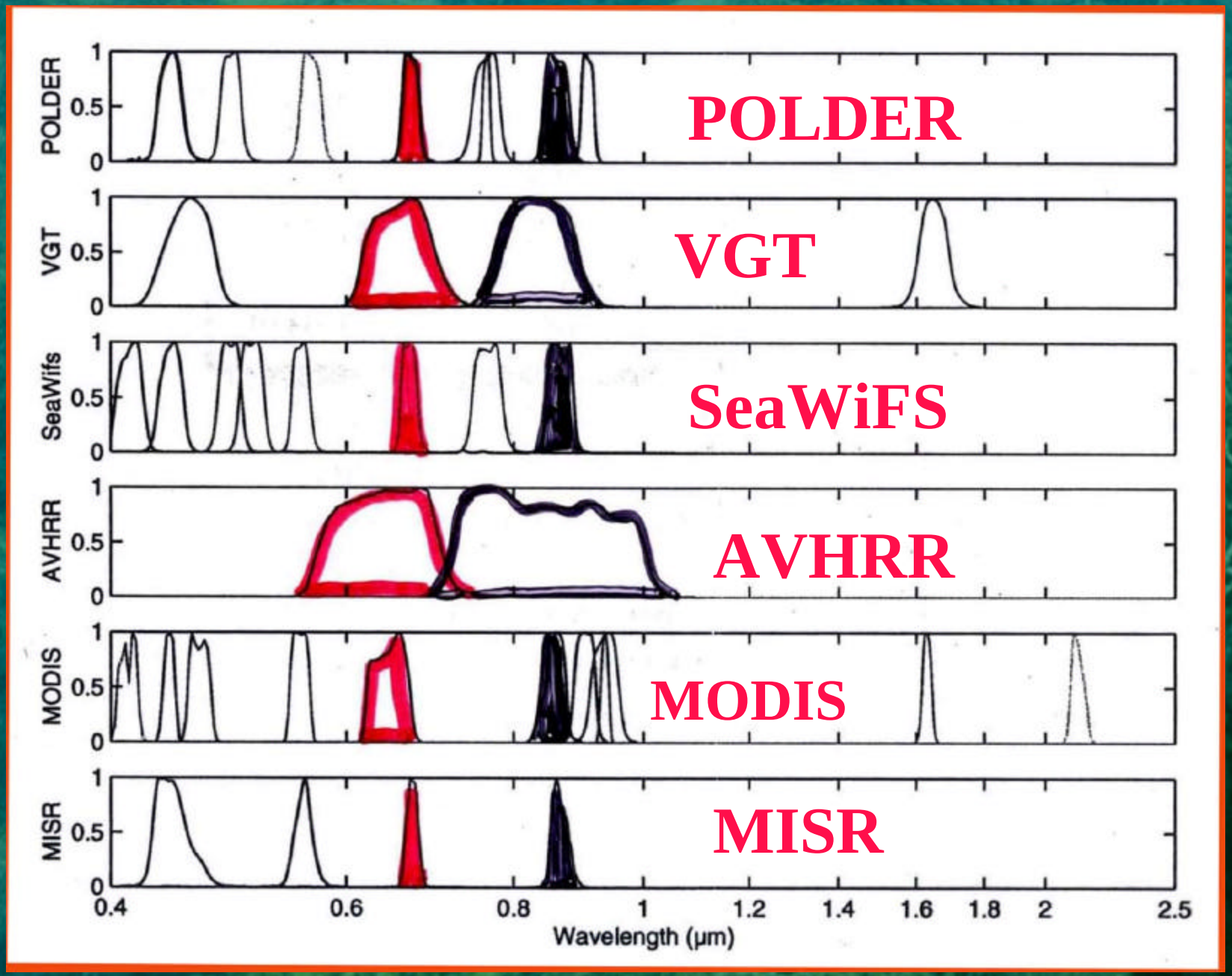
PAR = photosynthetically Active = Radiation (0.4 – 0.7 μm)



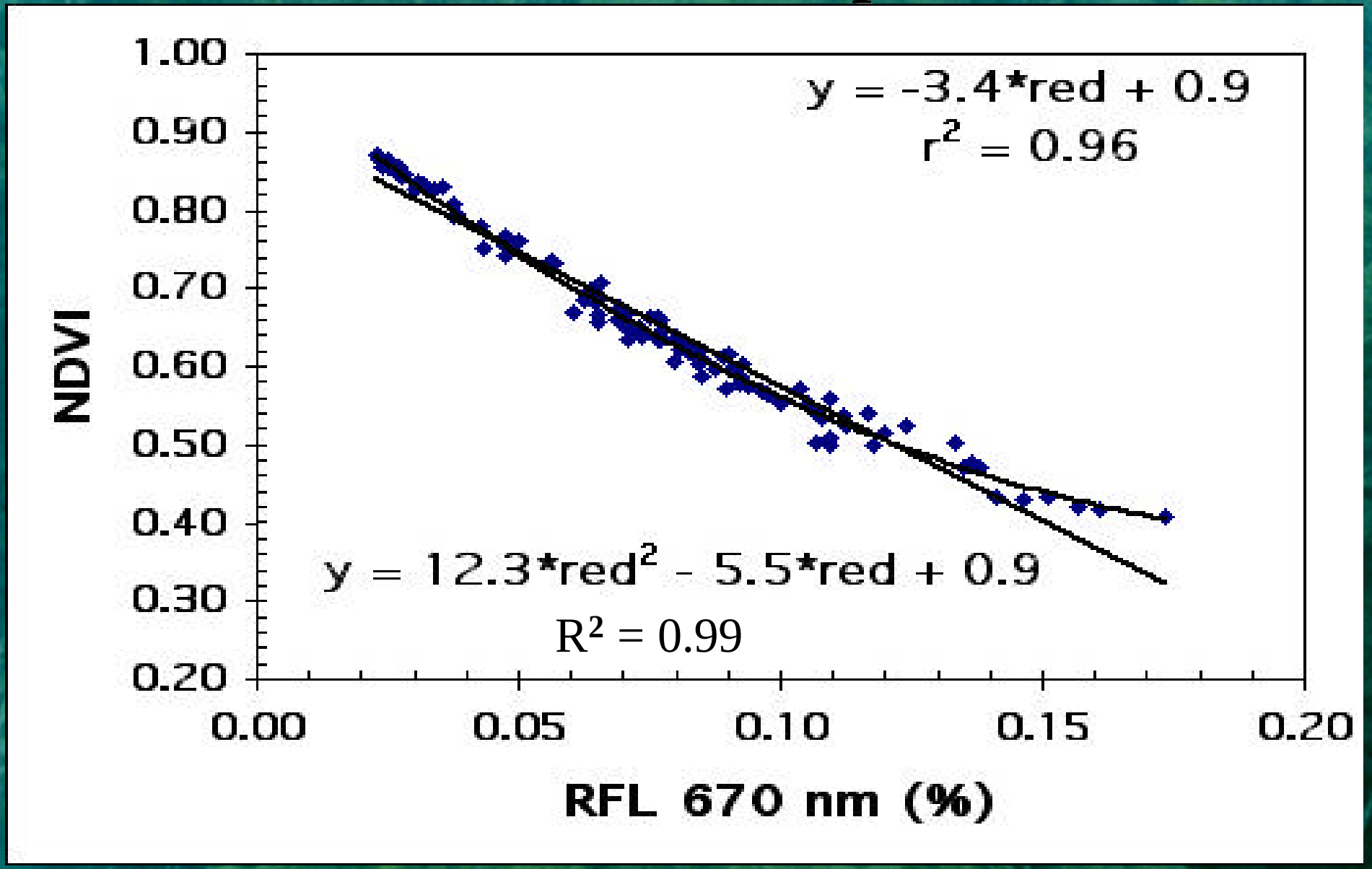
Ebola hemorrhagic fever outbreaks have occurred in African tropical rain forest or in gallery tropical forest



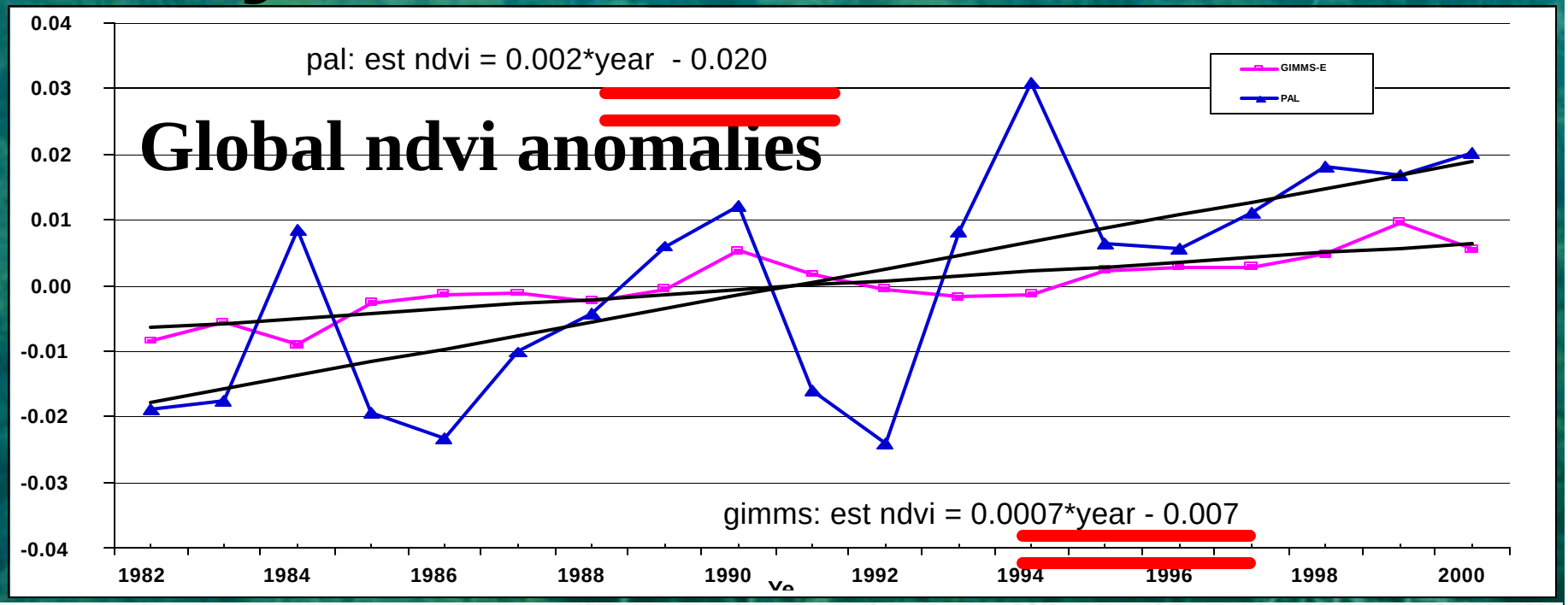
VIS/NIR/SWIR Band Comparison

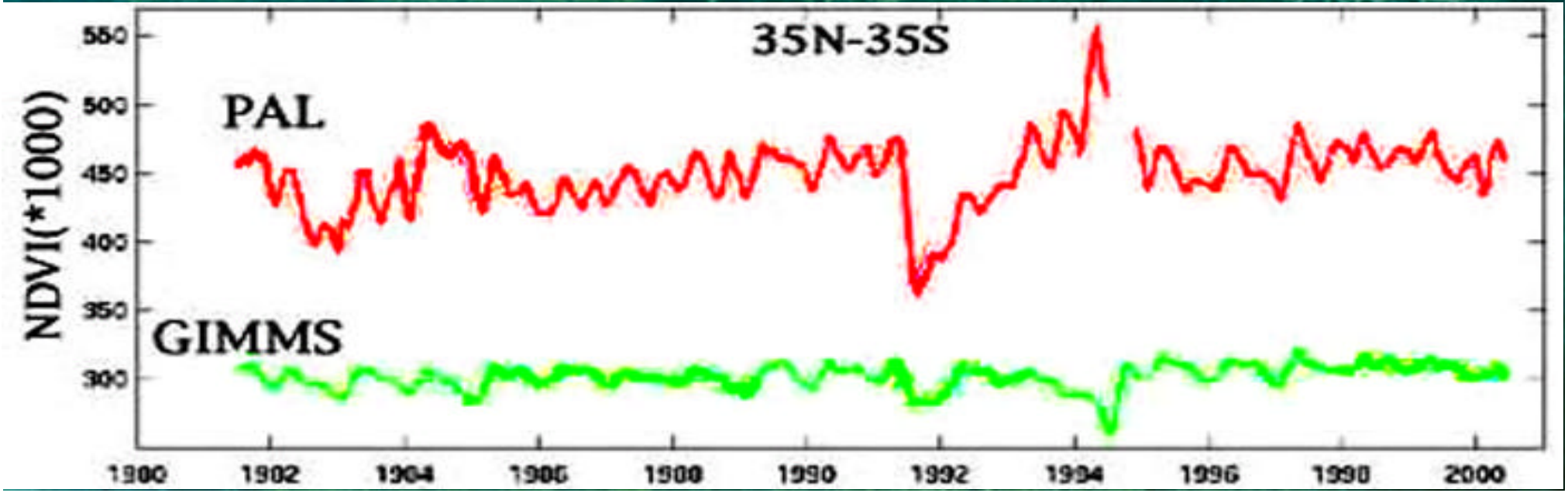


Amazon RFL 670 & NDVI SeaWiFS Rayleigh & ozone corrected composited data

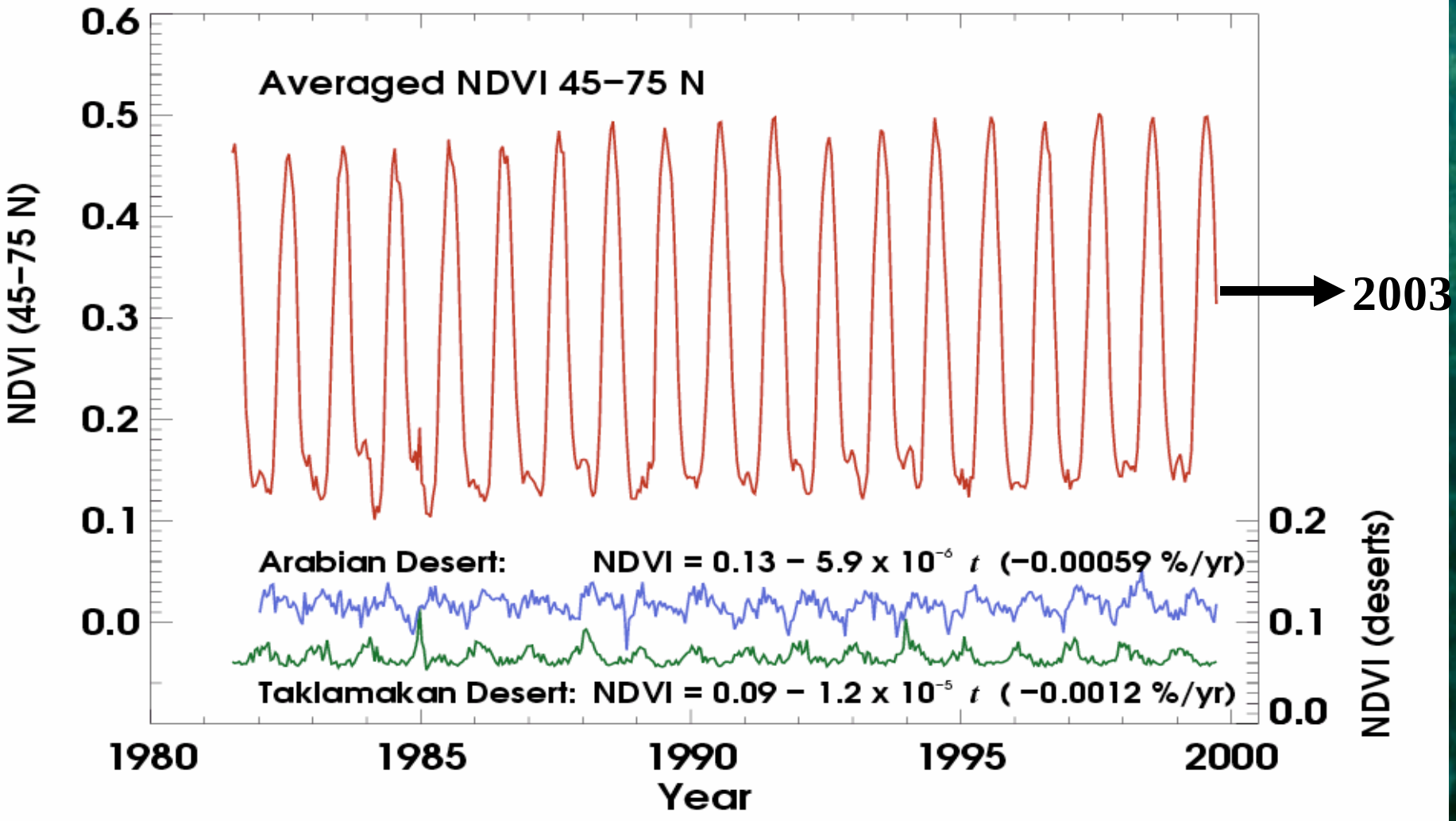


Major Data Set Differences

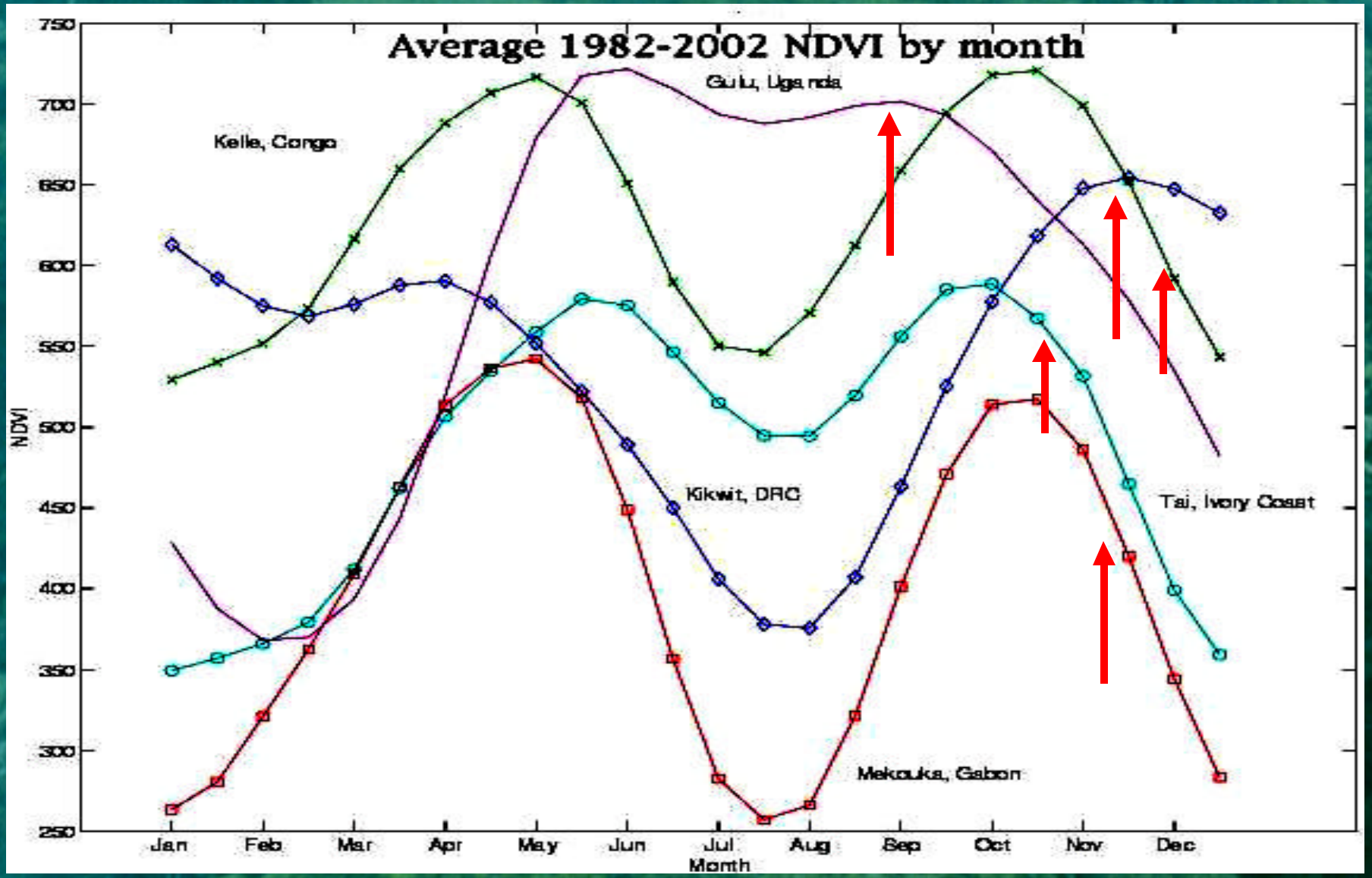




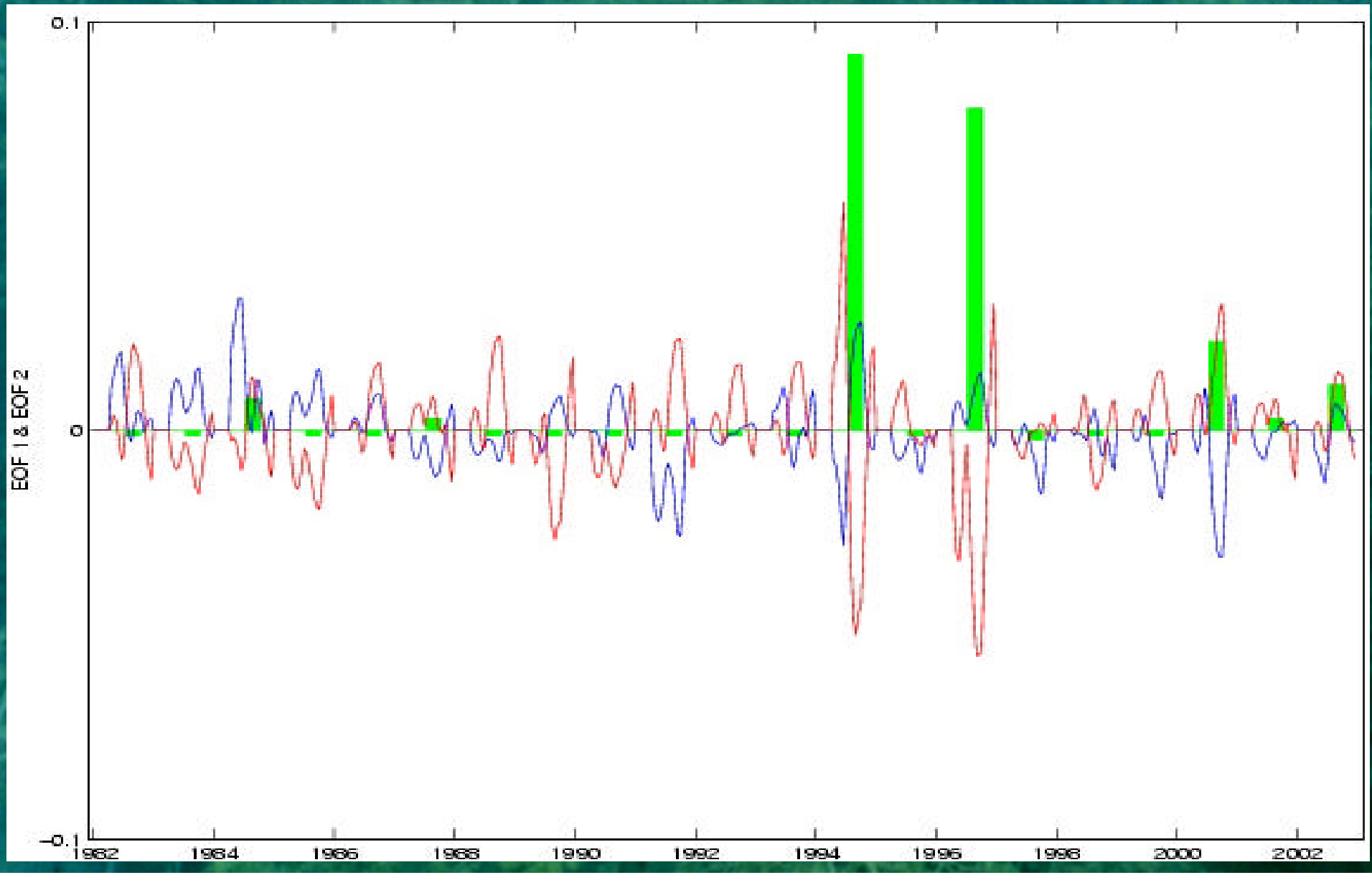
New, improved 8-km AVHRR NDVI data set 1981-2003



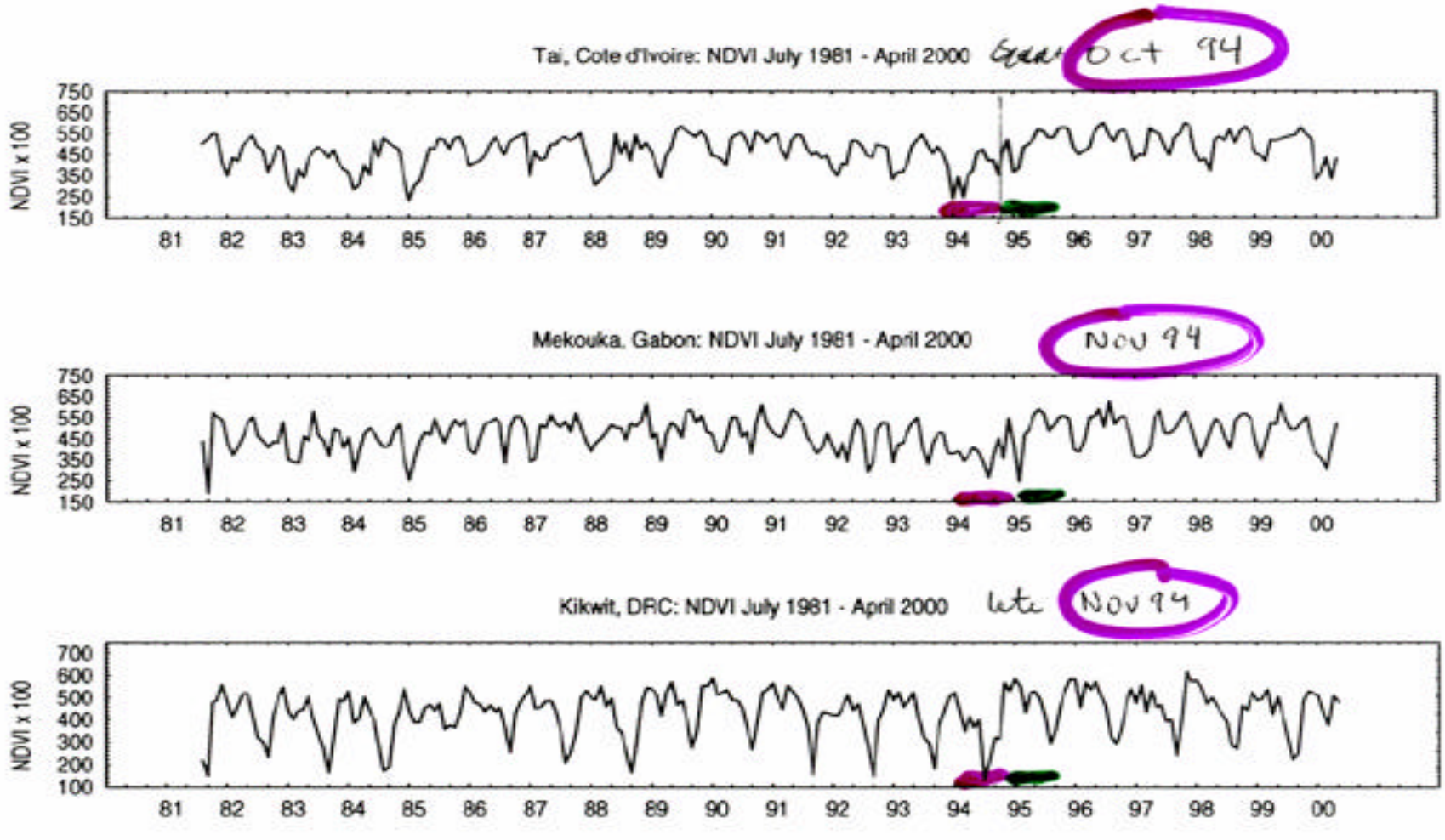
Hypothesis: very extreme changes from rainy to dry season



Canonical Correlation Analysis

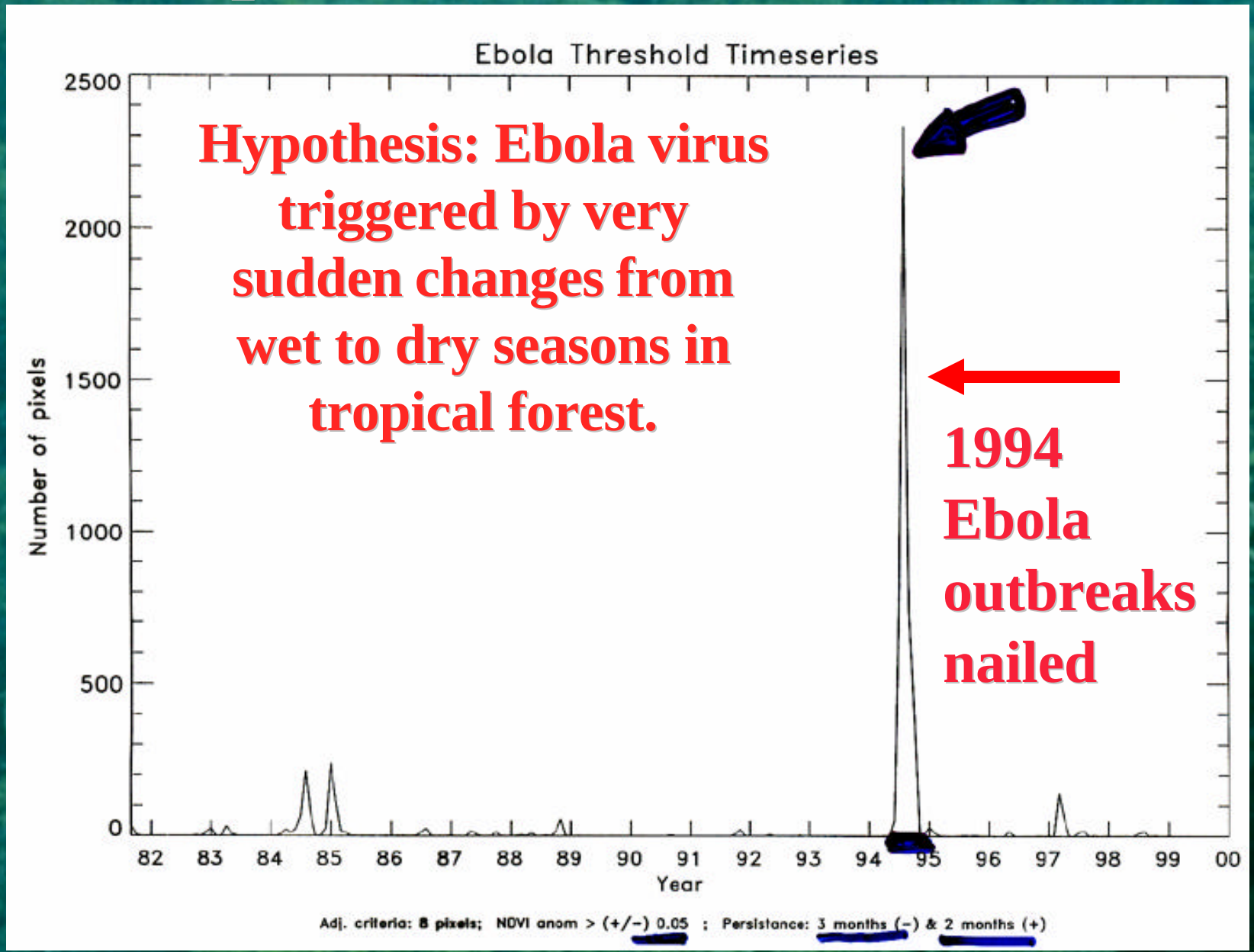


1994 Ebola Outbreak Locations NDVI Time Series

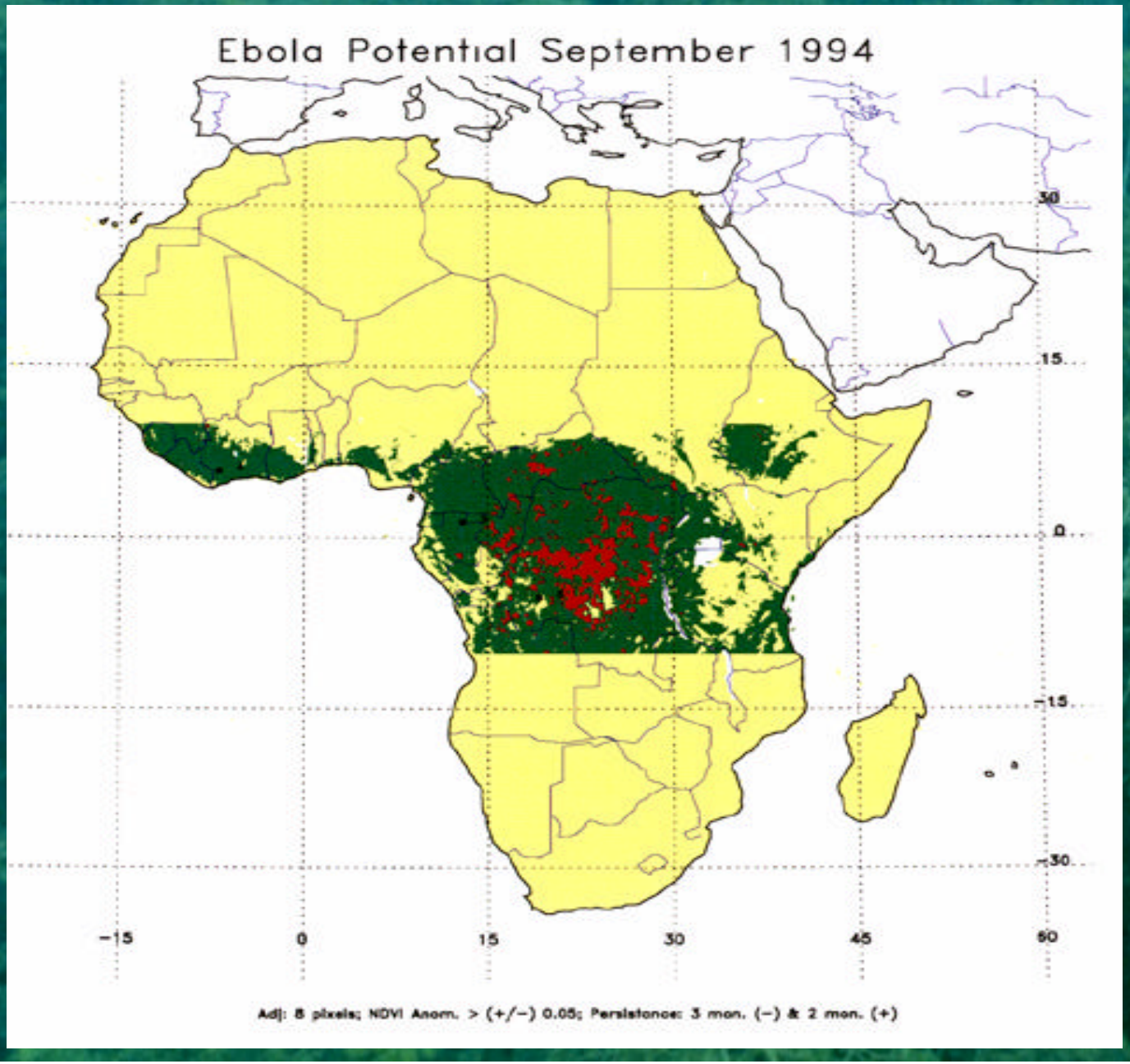


NDVI time series for selected Ebola outbreak sites

Total Tropical Stratum Pixels Affected



Areas Affected September 1994



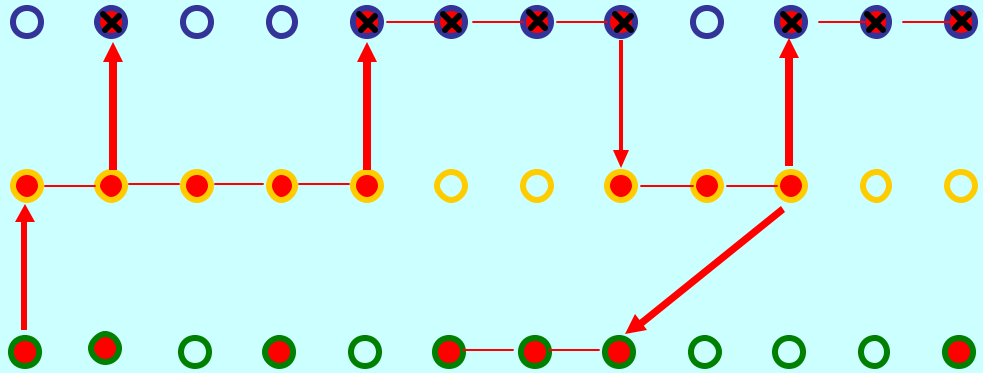
1994 Ebola Travel Distances

0.025 threshold			distance from nearest area to Tai (km)	distance from nearest area to Mekouka (km)	distance from nearest area to Kikwit (km)
year	date	number of flagged pixels	Oct. 1994	Nov. 1994	Dec. 1994
1994	July	603	382	294	32
1994	August	4,982	394	215	40
1994	September	9,962	324	190	50
1994	October	3,983	140	29	142
1994	November	2,425	90	18	650
1994	December	159	181	449	421
1995	January	222	[illegible]	[illegible]	[illegible]
1995	February	576	[illegible]	[illegible]	8
1995	March	416	[illegible]	[illegible]	[illegible]
1995	April	230	1,791	51	236

2 out of 3 <50 km

Community Epidemic Scenario

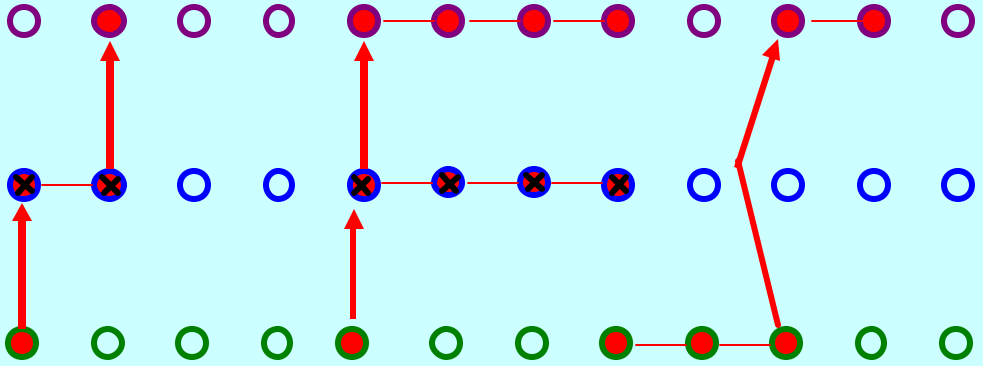
- Secondary transmission within species.
- Reciprocal transmission between species.

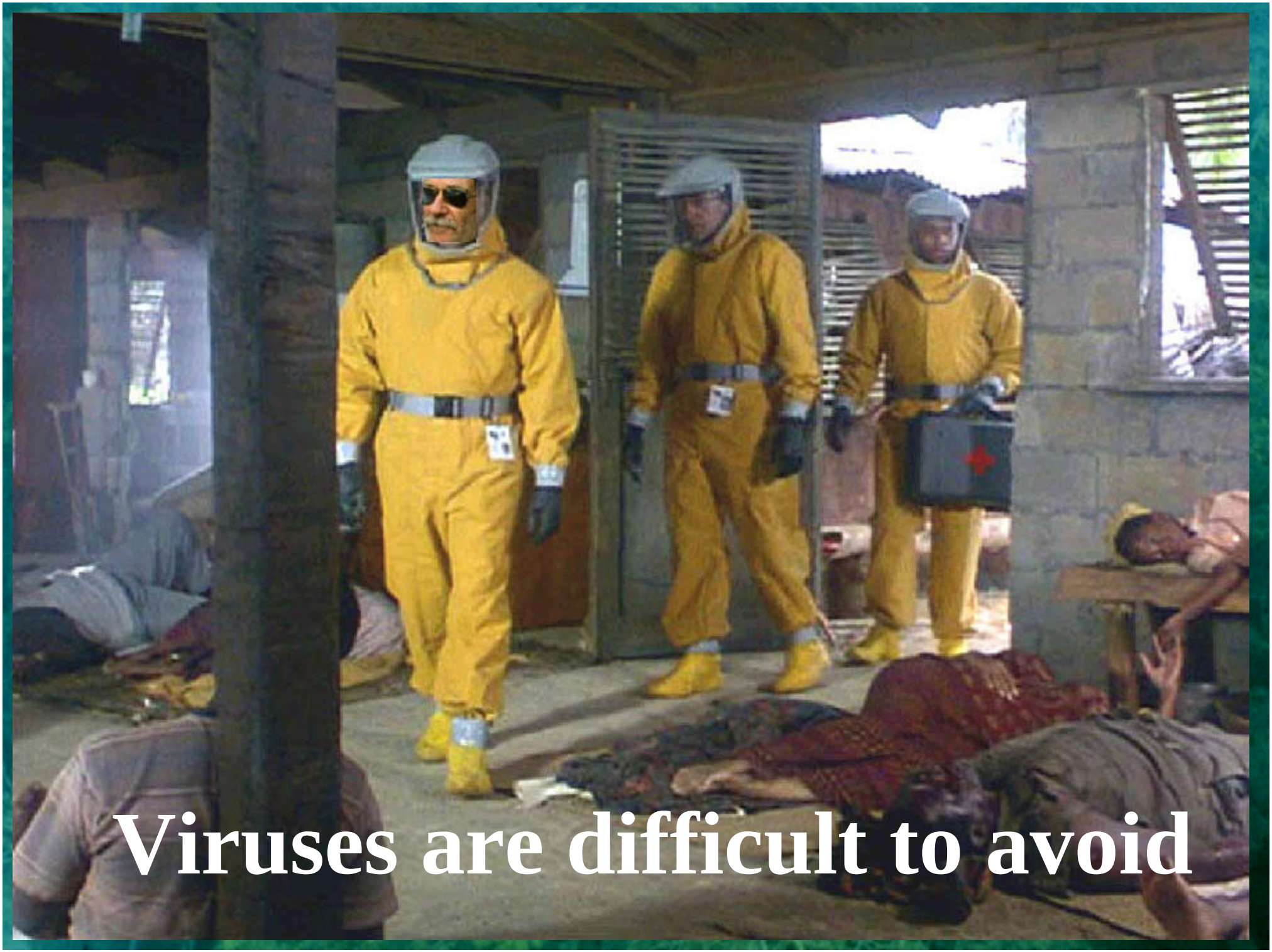


Peter Walsh et al. *Nature* (2003)

"Cul de Sac" Hosts

Just because a species tests positive for virus or antibodies does not mean that it is a link in the chain of transmission to apes.




Viruses are difficult to avoid